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MEMORANDUM REPORT

NO. WAL 710/633

Effect of Hardness on Resistance of a Thin-Gauge (.039" to .042") Modified SAE 4340 Steel

to Ferforation by Fragment-Simulating Projectiles

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BY

J. F. SULLIVAN 26 May 1961

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DATE 17 May 1944

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17 May 1944

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(.039" to .042") Modified SAE 4340 Steel

to Perforation by Frament-Simulating Projectiles

- l. In conjunction with a program of development of improved body armor components which is being conducted at this arsenal in response to a request of the Office, Chief of Ordnancel, tests have recently been completed on samples of a modified SAE 4340 steel in three conditions of hardness.
- 2. No substantial difference in the perforation resistance of samples of this steel at 29/31 Rockwell "C" and samples at 52 Rockwell "C" was evident. The plates tended to fail because of directional weaknesses probably due to non-metallic inclusions present in stringer form. The resistance of none of these samples was comparable with that of Hadfield manganese steel of equivalent weight.
- 3. Samples of each condition of hardness were clamped rigidly to a wooden ballistic frame which allows an 8"x8" area to remain unsupported from the rear and impacts of caliber .45 ball projectiles and three types of fragment-simulating projectiles developed at this arsenal? 3 were directed into these areas. The results are summarised in Table I.
- 1. 0.0. 422.3/71(c) Wtn 470.5/7443(c) dated 28 September 1943.
- 2. WAL Memorandum Report No. 762/274(c) "Development of Projectiles to Be Used in Testing Body Armor to Simulate Flak and 20 mm. H.E. Fragment" 17 December 1943.
- 3. WAL Memorandum Report No. 762/253(c) "Development of a Projectile to Be Used in Testing Body Armor, to Simulate Fragments of a 20 mm. H.E. Projectile" 7 January 1944.

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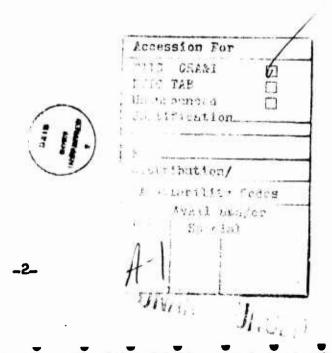
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- 4. Under impact of the caliber .45 ball projectile and of the light-weight fragment simulator, 6-2, the resistance of the samples in the intermediate hardness condition (38/40 Rockwell "C") was considerably lower (PTP at 493 feet-per-second and ballistic limit at 1043 feet-persecond, respectively) than that of either of the samples at the extremes in hardness (28/31 Rockwell "C" and 47/52 Rockwell "C") which were comparable with each other (592 feet-per-second and 626/646 feet-persecond and 1104 feet-per-second and 1129 feet-per-second, respectively). All values were substantially lower than those typical of Hadfield manganese steel (900 feet-per-second and 1600 feet-per-second).
- 5. Under impact of the caliber .30 light-weight fragment simulator, G-1-S, the resistance of samples in the three hardness conditions was substantially identical (820, 817 and 810 feet-per-second) and inferior to that of average Hadfield steel (900 feet-per-second).
- 6. Under impact of the heavy weight caliber .30 projectile G-1-A the resistance of the softer material (405 feet-per-second) was superior to that of the harder types (342 and 325 feet-per-second) but inferior to that of Hadfield which (on the basis of a limited number of tests) is estimated at about 500 feet- er-second.
- 7. The general resistance of this steel in any of the hardness conditions represented was so inferior to Hadfield manganese steel as to discourage its further consideration as a prospective body armor component although some of its inferiority may be attributable to directional weaknesses which were doubtless induced by non-metallic inclusions present in stringer form.

J. P. SULLIVAN
Jr. Engineer

APPROVED:

N. A. MATTHEWS
Major, Ordnance Dept.
Chief, Armor Section



Summary of Ballistic Tests Conducted at Watertown Arsenal
on Thin-gauge Samples of a Modified SAE 4340 Steel

in Three Conditions of Hardness

Nominal Chemical Composition													
C	Mn	P	S	S1	N1	Cr_	Mo	<u> </u>					
.30/.40	.50/.80	.025 max.	.025 max.	.20/.35	1.50/2.00	.70/.90	.25/.50	.15 min.					

				Ballistic Limit				
Sample	Hardn	088	Gauge	G-1-A1	G-1-5 ²	G_23	Cal. 454	
Item 4 Normalised, oil quenched and tempered	28 29 31	Rc	.042" .040"	405	820	1104	592	
Item 5 Normalized, bil quenched and tempered	38 39 40	Rc	.040" .040"	342	817	1043	493 (PTP)	
Item f Normalized, oil quenched and tempered	^{1:} 7 52		.039" .039"	325 	810	1129	6 26 646	
For comparison: Hadfield manganese steel	8 8	Ρъ	.040 ⁿ	*****	900	1600	900	

¹Caliber .30 fragment simulating Projectile - 150 grains

²Caliber .30 fragment simulating projectile 34 grains

³Caliber .22 fragment simulating projectile - 17 grains

⁴Caliber .45 steel jacketed ball projectile - 230 grains